Never stop thinking

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS C6

600V CoolMOS™ C6 Power Transistor
IPx60R190C6

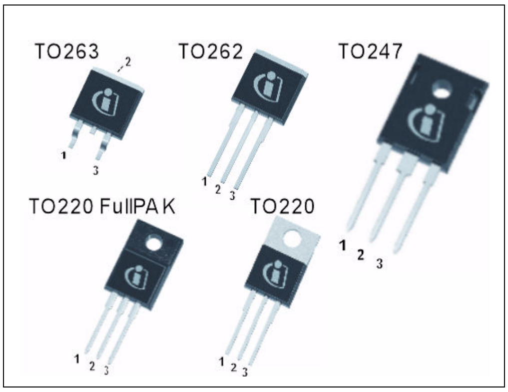
Data Sheet

Rev. 2.1, 2010-02-09
Final

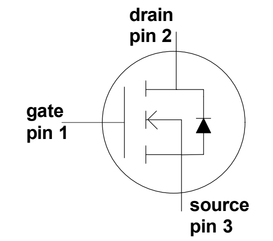
Industrial & Multimarket

1 Description

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ C6 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The offered devices provide all benefits of a fast switching SJ MOSFET while not sacrificing ease of use. Extremely low switching and conduction losses make switching applications even more efficient, more compact, lighter, and cooler.



RoHS



Features

- Extremely low losses due to very low FOM Rdson*Qg and Eoss
- Very high commutation ruggedness
- Easy to use/drive
- JEDEC[1] qualified, Pb-free plating, Halogen free

Applications

PFC stages, hard switching PWM stages and resonant switching PWM stages for e.g. PC Silverbox, Adapter, LCD & PDP TV, Lighting, Server, Telecom, UPS and Solar.

Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.

Table 1 Key Performance Parameters

Parameter	Value	Unit
V_{DS} @ $T_{j,max}$	650	V
$R_{DS(on),max}$	0.19	Ω
$Q_{g,typ}$	63	nC
$I_{D,pulse}$	59	A
E_{oss} @ 400V	5.2	µJ
Body diode di/dt	500	A/µs

Type / Ordering Code	Package	Marking	Related Links
IPW60R190C6	PG-TO247	6R190C6	IFX C6 Product Brief
IPB60R190C6	PG-TO263		IFX C6 Portfolio
IPI60R190C6	PG-TO262		IFX CoolMOS Webpage
IPP60R190C6	PG-TO220		IFX Design tools
IPA60R190C6	PG-TO220 FullPAK		

1) J-STD20 and JESD22

Table of Contents

2 Maximum ratings

at T_j = 25 °C, unless otherwise specified.

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current[1)]	I_D	-	-	20.2	A	T_C= 25 °C
				12.8		T_C= 100°C
Pulsed drain current[2)]	$I_{D,pulse}$	-	-	59	A	T_C=25 °C
Avalanche energy, single pulse	E_{AS}	-	-	418	mJ	I_D=3.4 A, V_{DD}=50 V (see table 21)
Avalanche energy, repetitive	E_{AR}	-	-	0.63		I_D=3.4 A, V_{DD}=50 V
Avalanche current, repetitive	I_{AR}	-	-	3.4	A	
MOSFET dv/dt ruggedness	dv/dt	-	-	50	V/ns	V_{DS}=0...480 V
Gate source voltage	V_{GS}	-20	-	20	V	static
		-30		30		AC (f>1 Hz)
Power dissipation for TO-220, TO-247, TO-262, TO-263	P_{tot}	-	-	151	W	T_C=25 °C
Power dissipation for TO-220 FullPAK	P_{tot}	-	-	34		
Operating and storage temperature	T_j, T_{stg}	-55	-	150	°C	
Mounting torque TO-220, TO-247		-	-	60	Ncm	M3 and M3.5 screws
Mounting torque TO-220 FullPAK				50		M2.5 screws
Continuous diode forward current	I_S	-	-	17.5	A	T_C=25 °C
Diode pulse current[2)]	$I_{S,pulse}$	-	-	59	A	T_C=25 °C
Reverse diode dv/dt[3)]	dv/dt	-	-	15	V/ns	V_{DS}=0...400 V, $I_{SD} \leq I_D$, T_j=25 °C
Maximum diode commutation speed[3)]	di_f/dt			500	A/µs	(see table 22)

1) Limited by $T_{j,max.}$ Maximum duty cycle D=0.75

2) Pulse width t_p limited by $T_{j,max}$

3) Identical low side and high side switch with identical R_G

3 Thermal characteristics

Table 3 Thermal characteristics TO-220 (IPP60R190C6),TO-247 (IPW60R190C6),TO-262 (IPI60R190C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.83	°C/W	
Thermal resistance, junction - ambient	R_{thJA}	-	-	62		leaded
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6 mm (0.063 in.) from case for 10 s

Table 4 Thermal characteristics TO-220 FullPAK (IPA60R190C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	3.7	°C/W	
Thermal resistance, junction - ambient	R_{thJA}	-	-	80		leaded
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6 mm (0.063 in.) from case for 10 s

Table 5 Thermal characteristics TO-263 (IPB60R190C6)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.83	°C/W	
Thermal resistance, junction - ambient	R_{thJA}	-	-	62		SMD version, device on PCB, minimal footprint
			35			SMD version, device on PCB, $6cm^2$ cooling area[1)]
Soldering temperature, wave- & reflow soldering allowed	T_{sold}	-	-	260	°C	reflow MSL1

1) Device on 40mm*40mm*1.5mm one layer epoxy PCB FR4 with $6cm^2$ copper area (thickness 70µm) for drain connection. PCB is vertical without air stream cooling.

4 Electrical characteristics

Electrical characteristics, at Tj=25 °C, unless otherwise specified.

Table 6 Static characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	600	-	-	V	V_{GS}=0 V, I_D=0.25 mA
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5		V_{DS}=V_{GS}, I_D=0.63mA
Zero gate voltage drain current	I_{DSS}	-	-	1	µA	V_{DS}=600 V, V_{GS}=0 V, T_j=25 °C
		-	10	-		V_{DS}=600 V, V_{GS}=0 V, T_j=150 °C
Gate-source leakage current	I_{GSS}	-	-	100	nA	V_{GS}=20 V, V_{DS}=0 V
Drain-source on-state resistance	$R_{DS(on)}$	-	0.17	0.19	Ω	V_{GS}=10 V, I_D=9.5 A, T_j=25 °C
		-	0.44	-		V_{GS}=10 V, I_D=9.5 A, T_j=150 °C
Gate resistance	R_G	-	8.5	-	Ω	f=1 MHz, open drain

Table 7 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	1400	-	pF	V_{GS}=0 V, V_{DS}=100 V, f=1 MHz
Output capacitance	C_{oss}	-	85	-		
Effective output capacitance, energy related[1]	$C_{o(er)}$	-	56	-		V_{GS}=0 V, V_{DS}=0...480 V
Effective output capacitance, time related[2]	$C_{o(tr)}$	-	266	-		I_D=constant, V_{GS}=0 V V_{DS}=0...480V
Turn-on delay time	$t_{d(on)}$	-	15	-	ns	V_{DD}=400 V, V_{GS}=13 V, I_D=9.5A, R_G= 3.4Ω (see table 20)
Rise time	t_r	-	11	-		
Turn-off delay time	$t_{d(off)}$	-	110	-		
Fall time	t_f	-	9	-		

1) $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(BR)DSS}$

2) $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(BR)DSS}$

Table 8 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	7.6	-	nC	V_{DD}=480 V, I_D=9.5A, V_{GS}=0 to 10 V
Gate to drain charge	Q_{gd}	-	32	-		
Gate charge total	Q_g	-	63	-		
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	

Table 9 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.9	-	V	V_{GS}=0 V, I_F=9.5A, T_j=25 °C
Reverse recovery time	t_{rr}	-	430	-	ns	V_R=400 V, I_F=9.5A, di_F/dt=100 A/µs (see table 22)
Reverse recovery charge	Q_{rr}	-	6.9	-	µC	
Peak reverse recovery current	I_{rrm}	-	30	-	A	

5 Electrical characteristics diagrams

Table 10

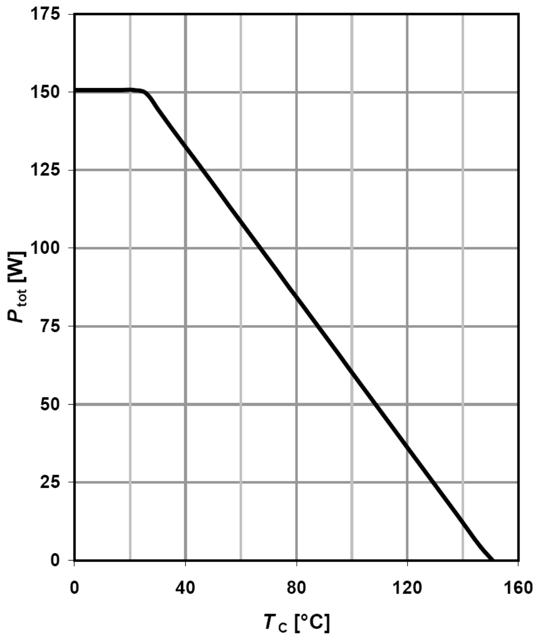
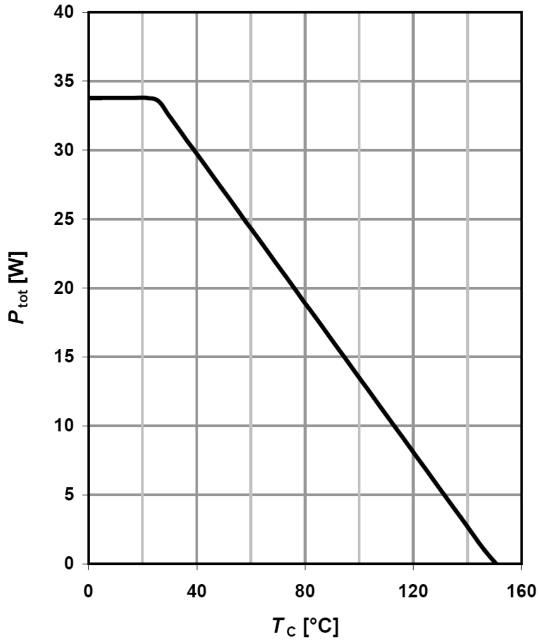
Power dissipation **TO-220, TO-247, TO-262, TO-263**	**Power dissipation** **TO-220 FullPAK**
	
$P_{tot} = f(T_C)$	$P_{tot} = f(T_C)$

Table 11

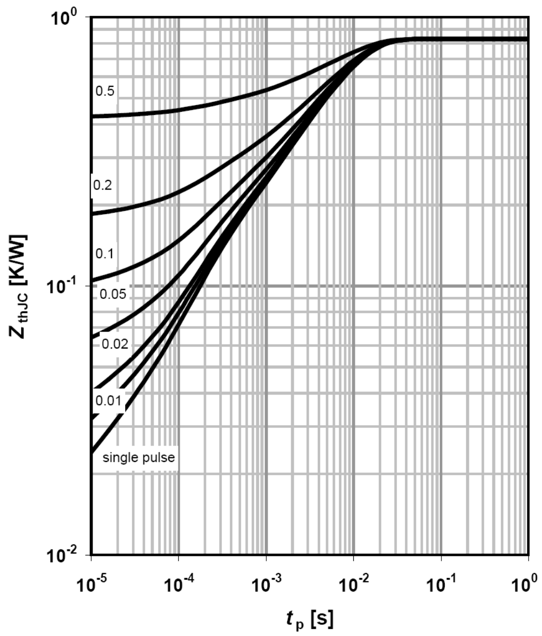
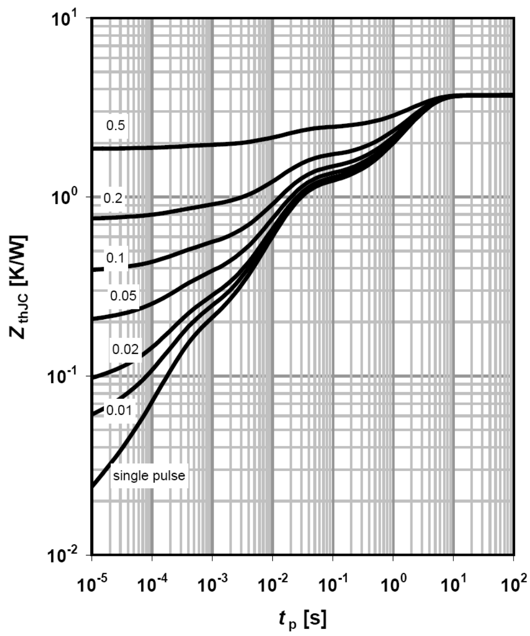
Max. transient thermal impedance **TO-220, TO-247, TO-262, TO-263**	**Max. transient thermal impedance** **TO-220 FullPAK**
	
$Z_{(thJC)}$=f(tp); parameter: D=t_p/T	$Z_{(thJC)}$=f(tp); parameter: D=t_p/T

Table 12

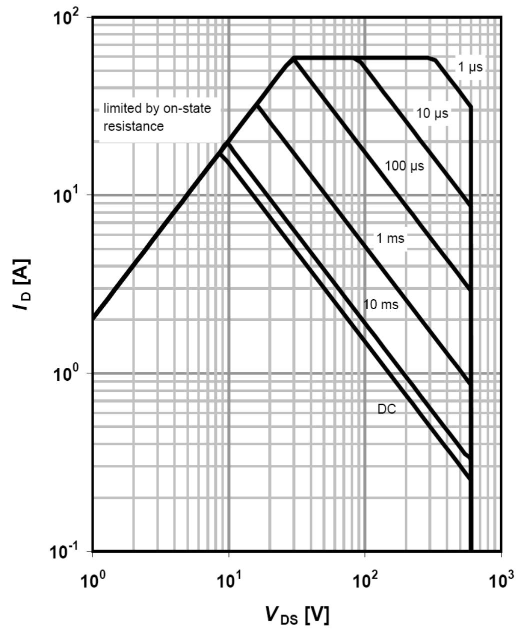
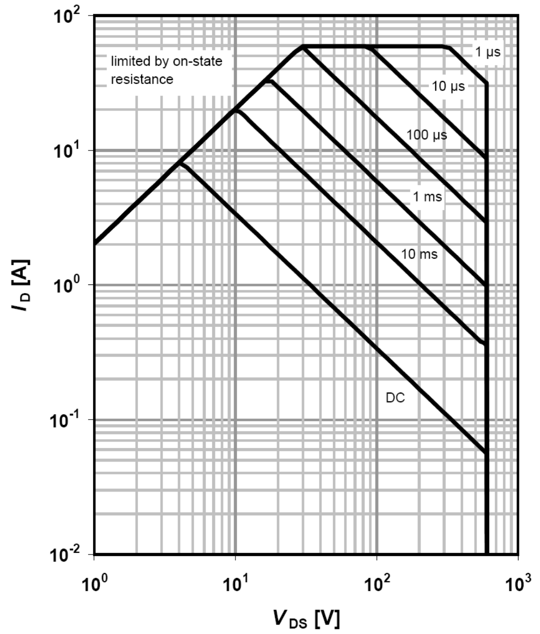
<table>
<tr><td>Safe operating area T_C=25 °C
TO-220, TO-247, TO-262, TO-263</td><td>Safe operating area T_C=25 °C
TO-220 FullPAK</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>I_D=f(V_{DS}); T_C=25 °C; D=0; parameter t_p</td><td>I_D=f(V_{DS}); T_C=25 °C; D=0; parameter t_p</td></tr>
</table>

Table 13

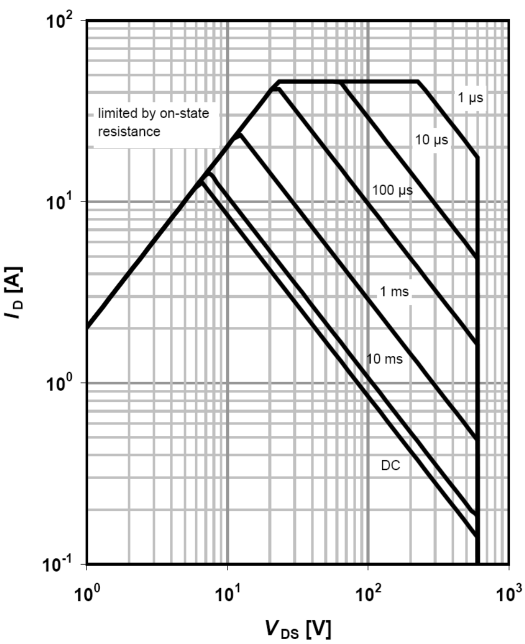
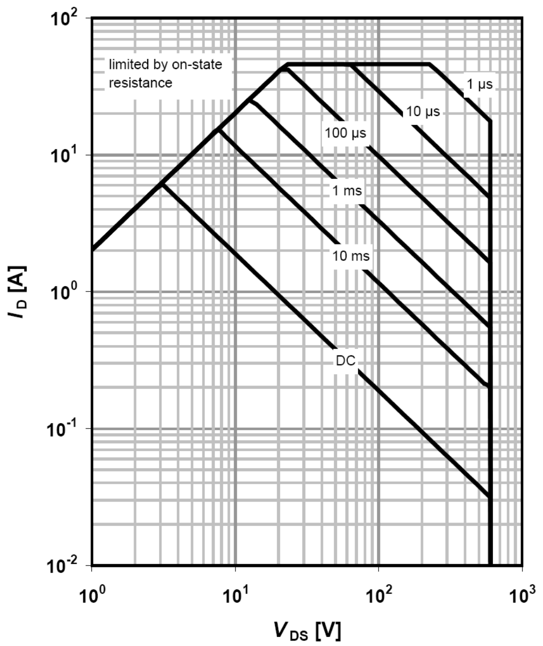
<table>
<tr><td>Safe operating area T_C=80 °C
TO-220, TO-247, TO-262, TO-263</td><td>Safe operating area T_C=80 °C
TO-220 FullPAK</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>I_D=f(V_{DS}); T_C=80 °C; D=0; parameter t_p</td><td>I_D=f(V_{DS}); T_C=80 °C; D=0; parameter t_p</td></tr>
</table>

Table 14

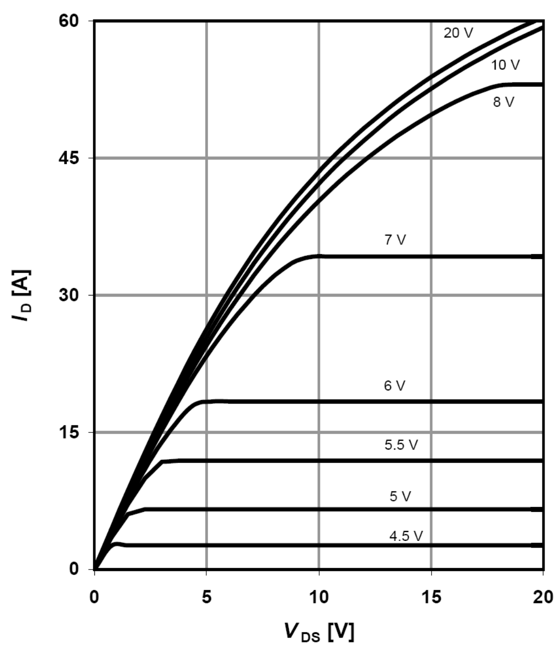
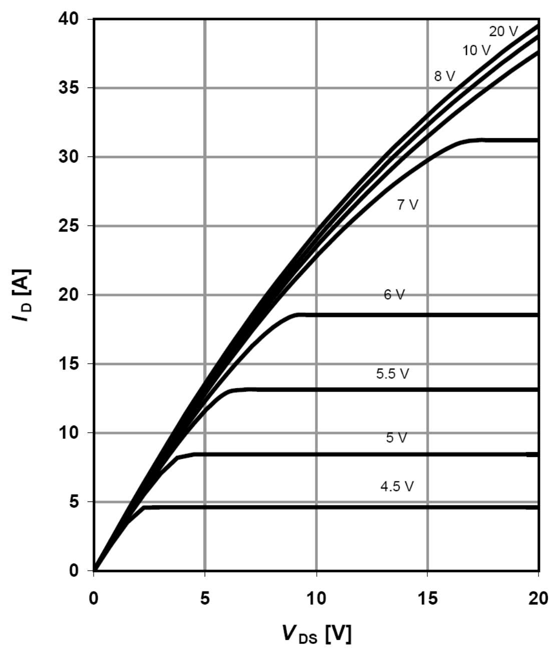
Typ. output characteristics T_j=25 °C	Typ. output characteristics T_j=125 °C
	
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}	I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

Table 15

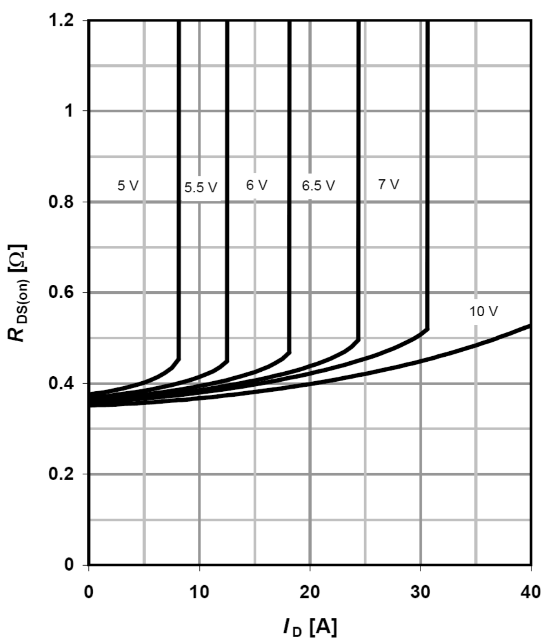
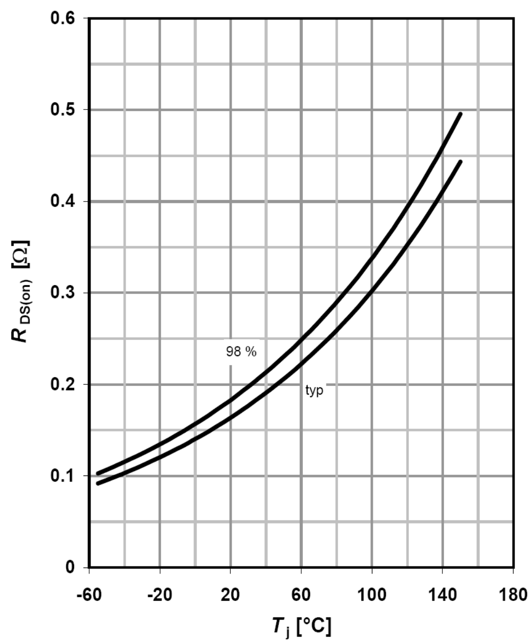
Typ. drain-source on-state resistance	Drain-source on-state resistance
	
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}	$R_{DS(on)}$=f(T_j); I_D=9.5 A; V_{GS}=10 V

Table 16

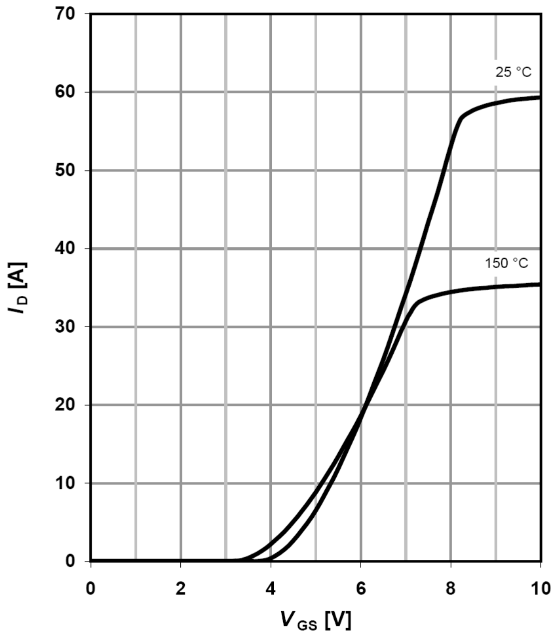
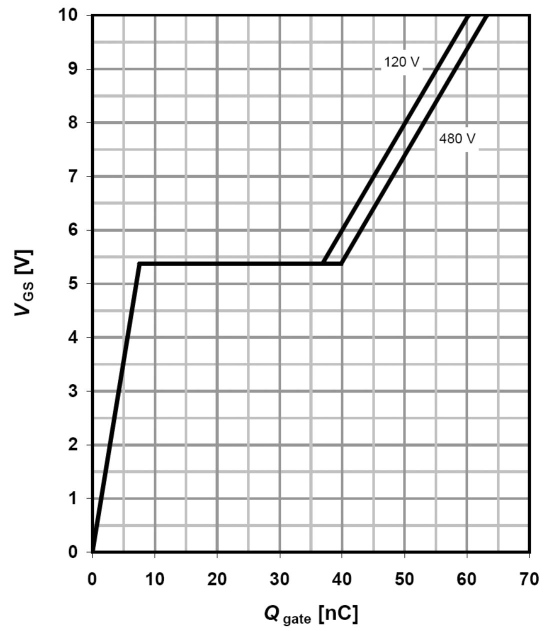
Typ. transfer characteristics	Typ. gate charge
	
I_D=f(V_{GS}); V_{DS}=20V	V_{GS}=f(Q_{gate}), I_D=9.5A pulsed

Table 17

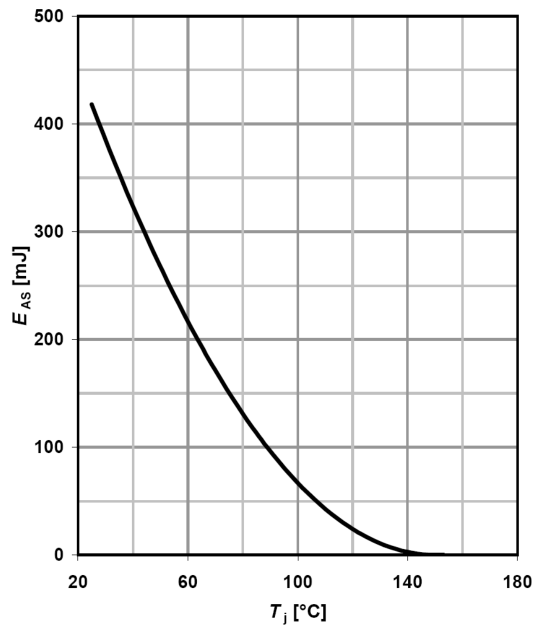
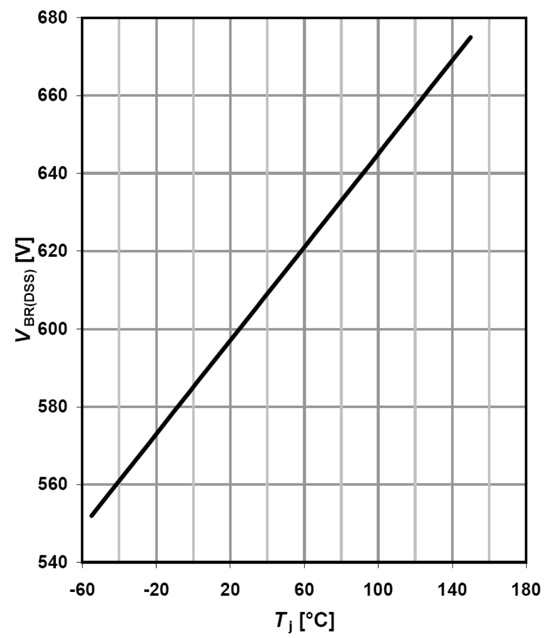
Avalanche energy	Drain-source breakdown voltage
	
E_{AS}=f(T_j); I_D=3.4 A; V_{DD}=50 V	$V_{BR(DSS)}$=f(T_j); I_D=0.25 mA

Table 18

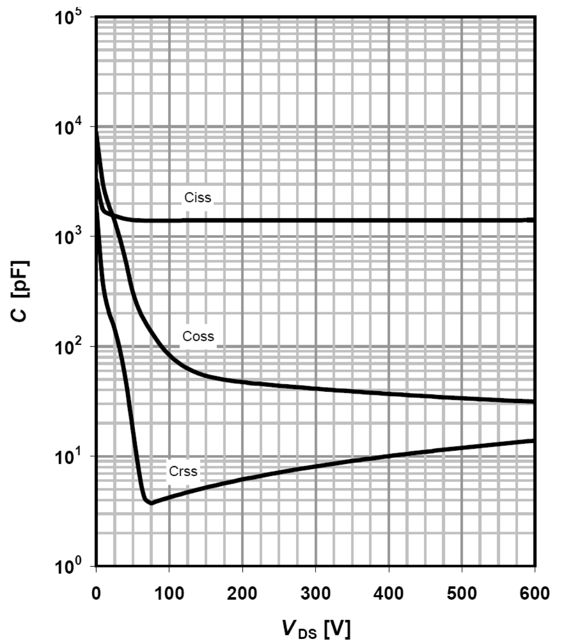
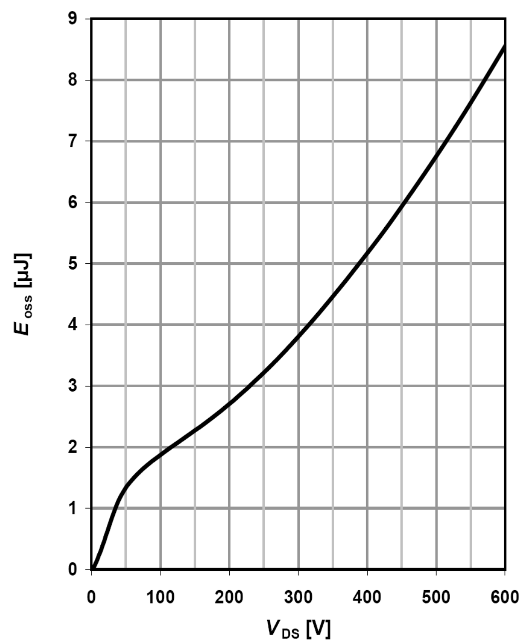
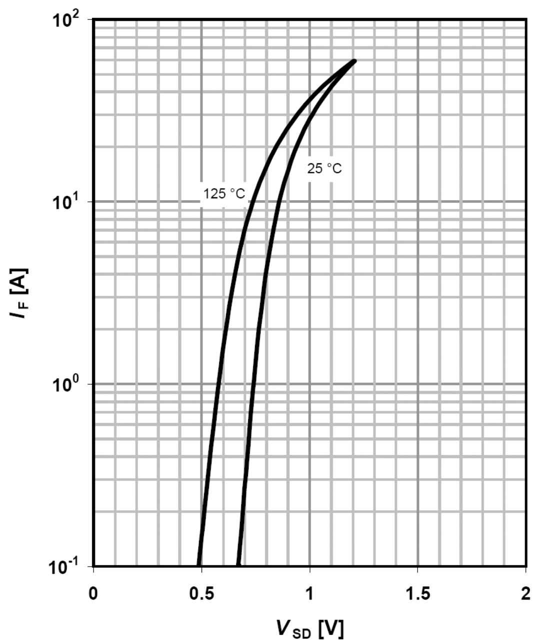
Typ. capacitances	Typ. C_{oss} stored energy
	
C=f(V_{DS}); V_{GS}=0 V; f=1 MHz	E_{oss}=f(V_{DS})

Table 19

Forward characteristics of reverse diode

I_F=f(V_{SD}); parameter: T_j

6 Test circuits

Table 20 Switching times test circuit and waveform for inductive load

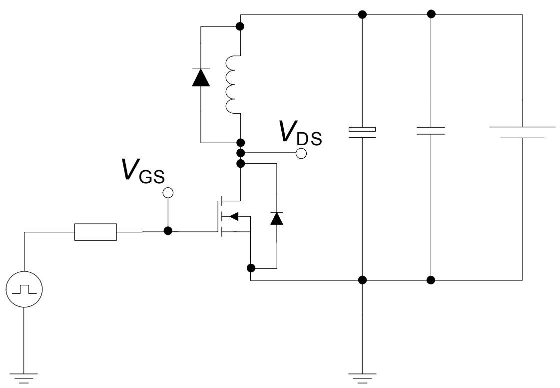
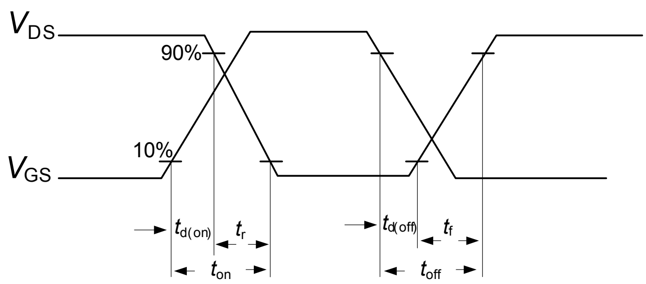
Switching times test circuit for inductive load	Switching time waveform
	

Table 21 Unclamped inductive load test circuit and waveform

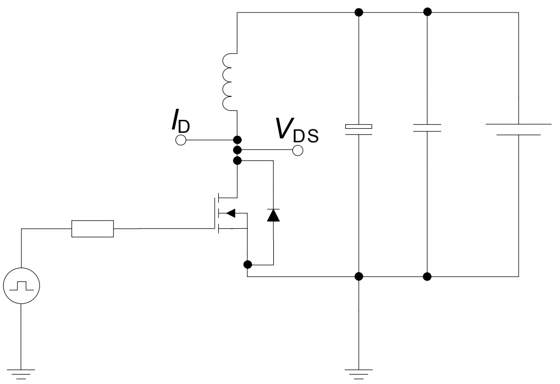
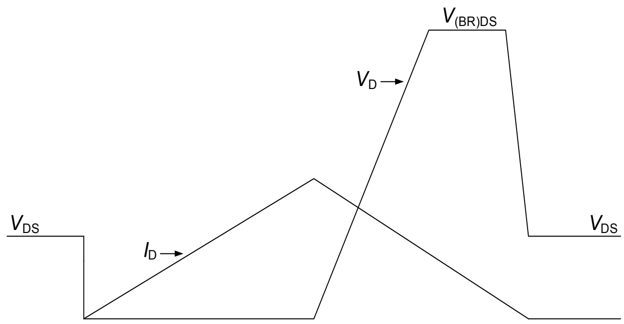
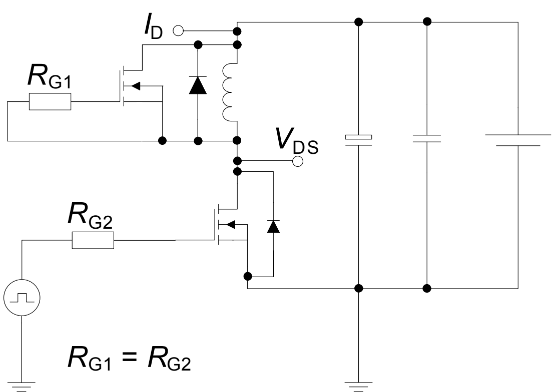
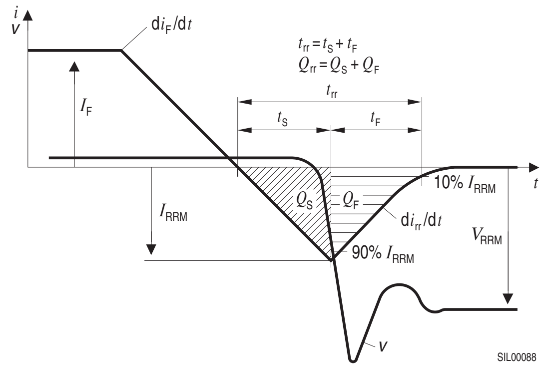
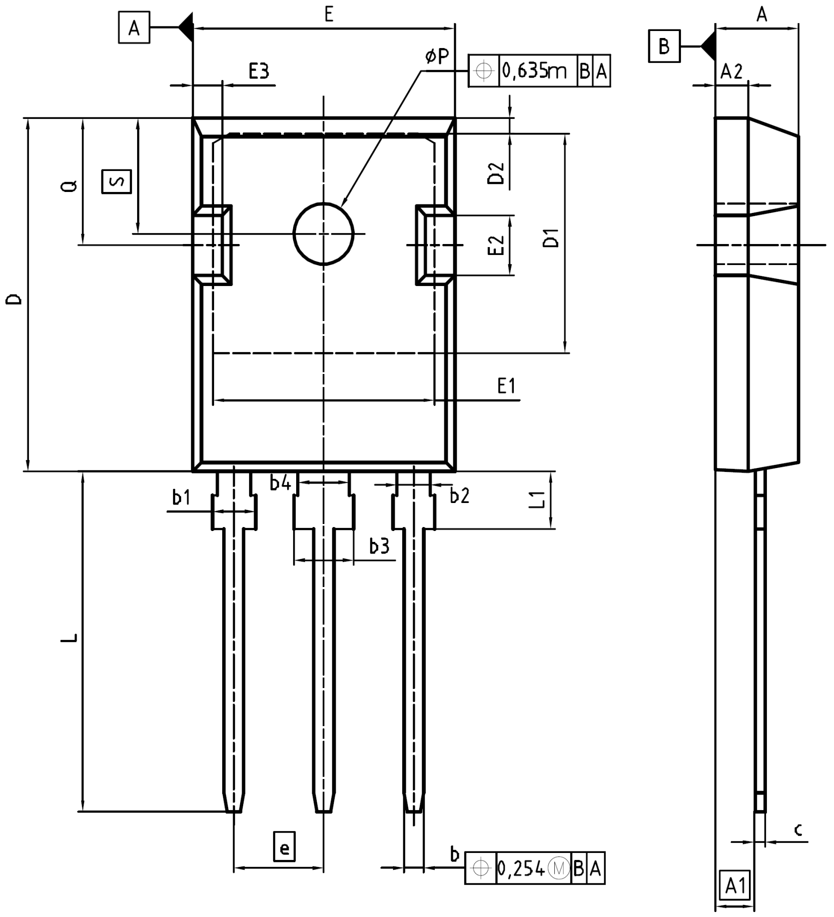
Unclamped inductive load test circuit	Unclamped inductive waveform
	

Table 22 Test circuit and waveform for diode characteristics

Test circuit for diode characteristics	Diode recovery waveform
	

7 Package outlines



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44		0.214	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
øP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

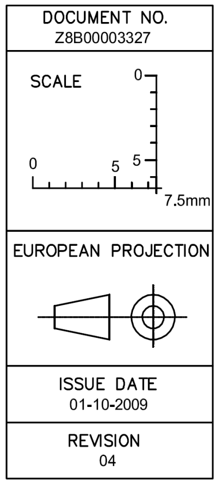
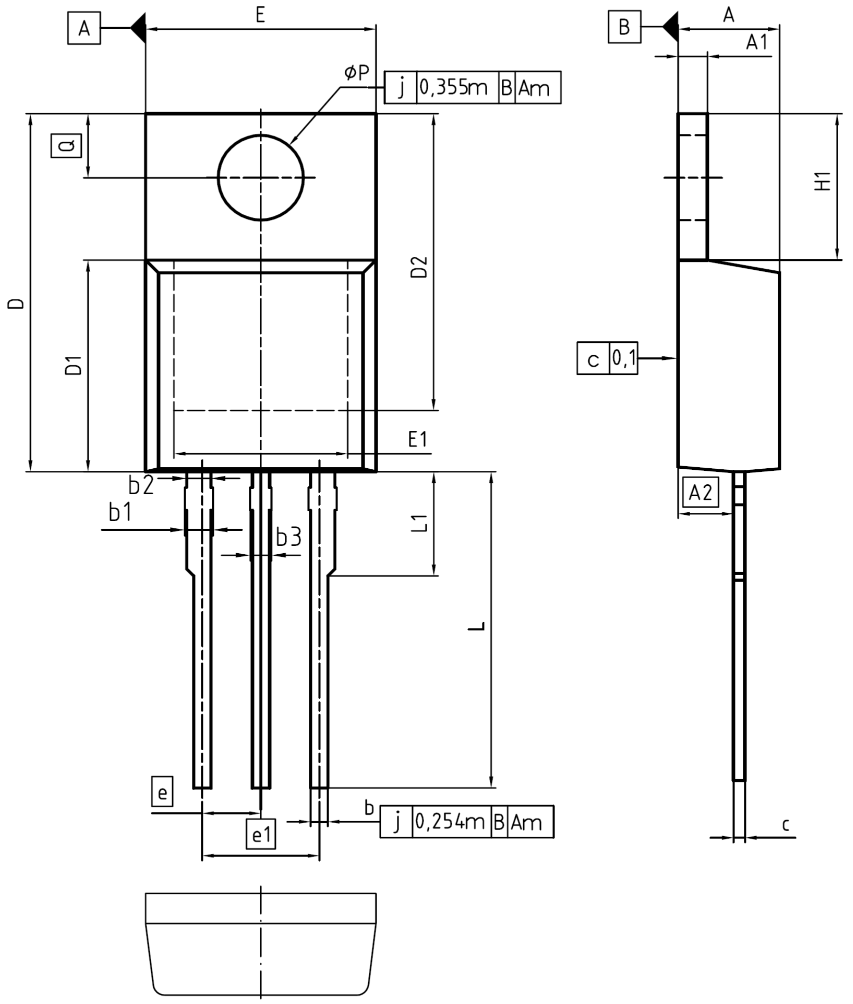


Figure 1 Outlines TO-247, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
øP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

DOCUMENT NO.
Z8B00003318

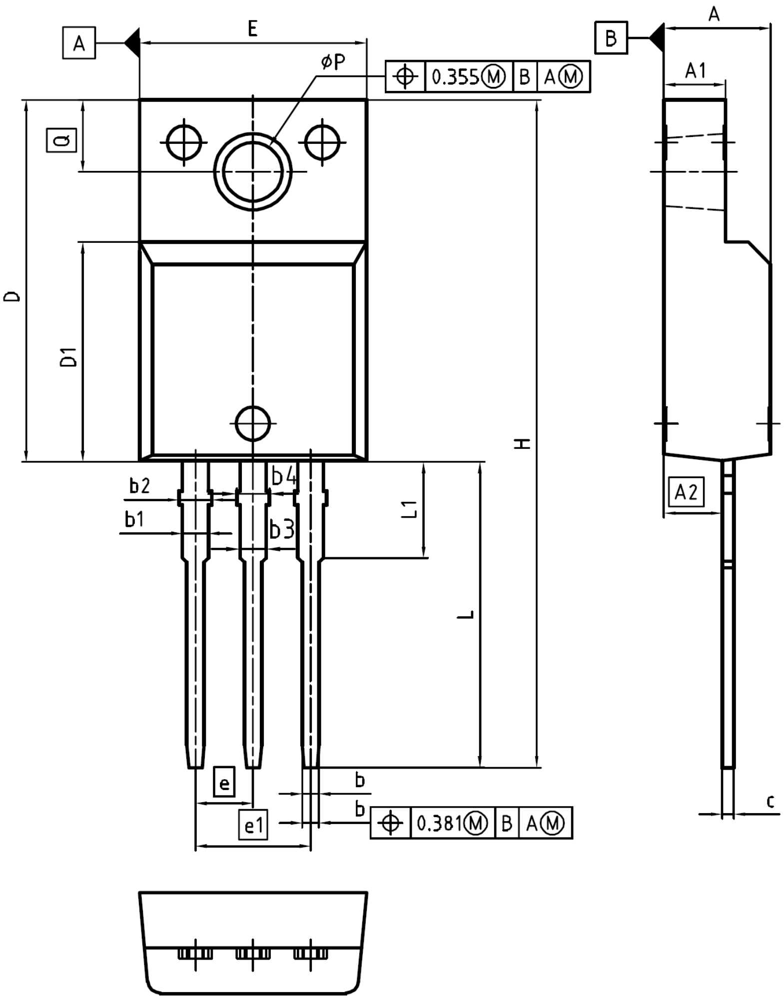
SCALE 0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE
23-08-2007

REVISION
05

Figure 2 Outlines TO-220, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.55	4.85	0.179	0.191
A1	2.55	2.85	0.100	0.112
A2	2.42	2.72	0.095	0.107
b	0.65	0.85	0.026	0.033
b1	0.95	1.33	0.037	0.052
b2	0.95	1.51	0.037	0.059
b3	0.65	1.33	0.026	0.052
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.85	16.15	0.624	0.636
D1	9.53	9.83	0.375	0.387
E	10.35	10.65	0.407	0.419
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H	29.45	29.75	1.159	1.171
L	13.45	13.75	0.530	0.541
L1	3.15	3.45	0.124	0.136
øP	2.95	3.20	0.116	0.126
Q	3.15	3.50	0.124	0.138

DOCUMENT NO.
Z8B00003319
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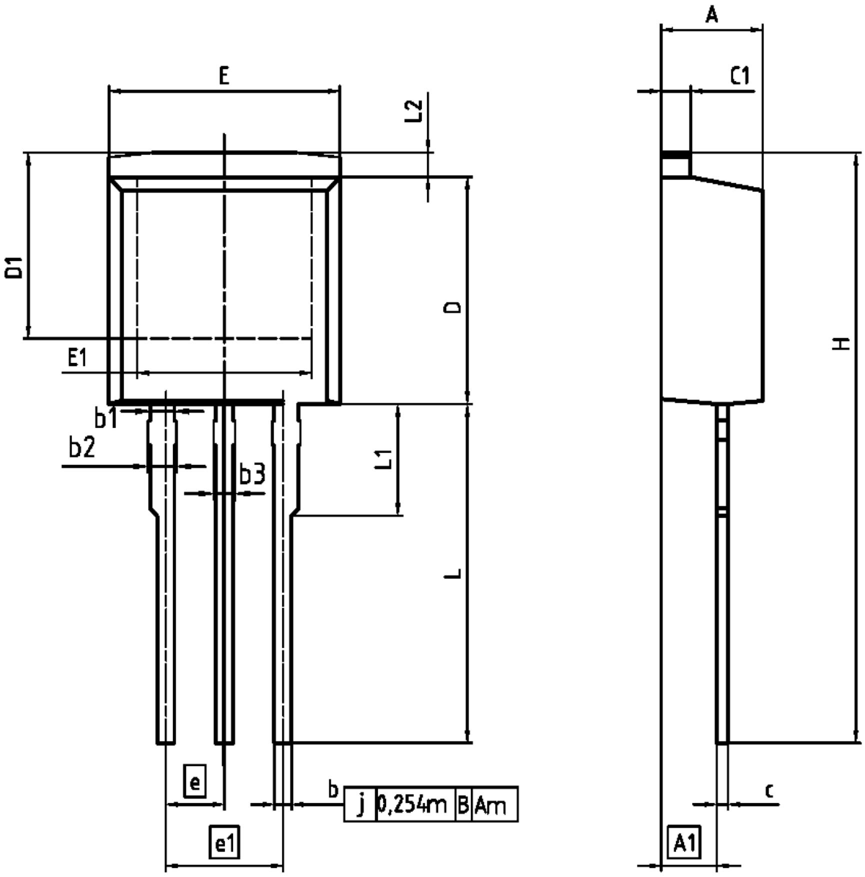
EUROPEAN PROJECTION
ISSUE DATE 08-03-2007
REVISION 03

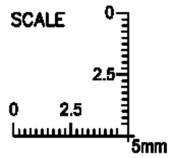
Figure 3 Outlines TO-220 FullPAK, dimensions in mm/inches



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.572	0.169	0.180
A1	2.150	2.718	0.085	0.107
b	0.650	0.864	0.026	0.034
b1	0.950	1.093	0.037	0.043
b2	0.950	1.400	0.037	0.055
b3	0.650	1.118	0.026	0.044
c	0.330	0.600	0.013	0.024
c1	1.170	1.400	0.046	0.055
D	8.509	9.450	0.335	0.372
D1	6.900	-	0.272	-
E	9.700	10.363	0.382	0.408
E1	6.500	8.600	0.256	0.339
e	2.540		0.100	
e1	5.080		0.200	
N	3		3	
L	13.000	14.000	0.512	0.551
L1	-	4.800	-	0.189
L2	-	1.727	-	0.068

REFERENCE
JEDEC TO262

SCALE



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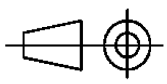
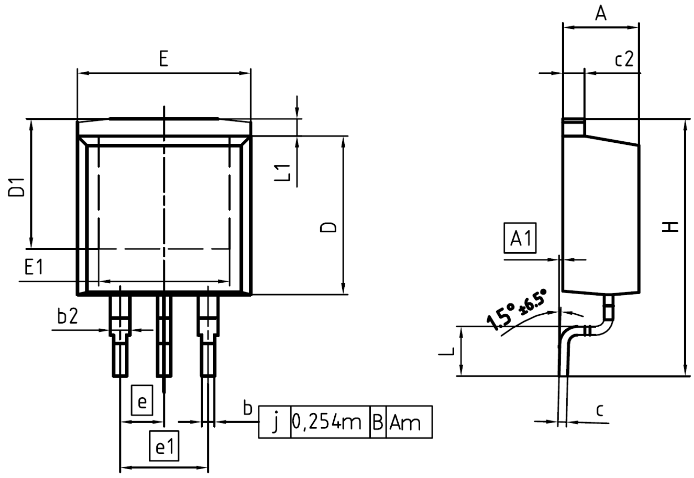


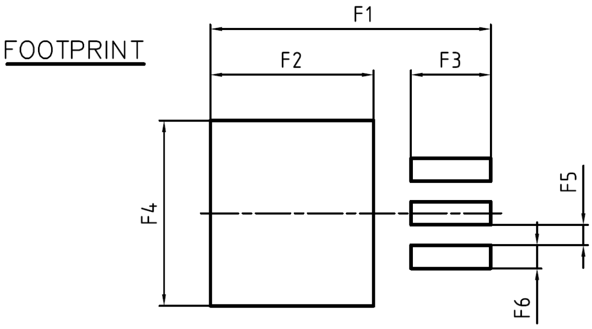
ISSUE DATE
05-05-2006

FILE
TO262_1

Figure 4 Outlines TO-262, dimensions in mm/inches

Package outlines

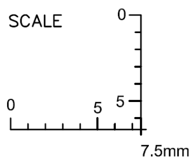




DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	0.00	0.25	0.000	0.010
b	0.65	0.85	0.026	0.033
b2	0.95	1.15	0.037	0.045
c	0.33	0.65	0.013	0.026
c2	1.17	1.40	0.046	0.055
D	8.51	9.45	0.335	0.372
D1	7.10	7.90	0.280	0.311
E	9.80	10.31	0.386	0.406
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H	14.61	15.88	0.575	0.625
L	2.29	3.00	0.090	0.118
L1	0.70	1.60	0.028	0.063
F1	16.05	16.25	0.632	0.640
F2	9.30	9.50	0.366	0.374
F3	4.50	4.70	0.177	0.185
F4	10.70	10.90	0.421	0.429
F5	1.10	1.30	0.043	0.051
F6	1.25	1.45	0.049	0.057

DOCUMENT NO.
Z8B00003323

SCALE



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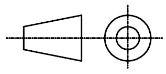

ISSUE DATE
30-08-2007

REVISION
01

Figure 5 Outlines TO-263, dimensions in mm/inches

8 Revision History

CoolMOS C6 600V CoolMOS™ C6 Power Transistor

Revision History: 2010-02-09, Rev. 2.1

Revision	Subjects (major changes since last revision)
2.0	Release of final data sheet
2.1	New package outlines TO-247

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